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∴ Total work=5275.3 ft. lbs.

$$\begin{aligned}\text{Internal work} &= \int_{p_1}^{p_2} (v - dv/dt) dp = \frac{3}{2t} [v(R^2 t^4 - 4bp_2 t) - v(R^2 t^4 - 4bp_1 t)] \\ &= -138.261 \text{ ft. lbs.}\end{aligned}$$

Let  $\gamma$  be the ratio of specific heat at constant pressure to specific heat at constant volume;  $S$ =dynamic specific heat at constant volume;  $u$ =velocity of sound in  $CO_2$ ,  $g$ =gravity,  $\delta$ =density of mercury,  $d$ =density of  $CO_2$ ,  $h$ =height of barometer.

Then  $u = \left( \frac{g\delta h[1 + (t/273)]\gamma}{d} \right)^{\frac{1}{2}}$ . Let  $t=0$ , then  $g=32.2$  feet.  $\delta=13.59$ ,  $h=29.92$  inches=2.4935 feet,  $d=.00198$ ,  $u$  by experiment=856 feet.

∴  $\gamma = du^2/g\delta h = 1.3296$ .

At  $0^\circ C.$ ,  $S = R/(\gamma - 1) = 63.23/.3296 = 191.84$ .

For any temperature,  $t$ ,  $S_t = B + t \int_{\infty}^v (d^2 p/dt^2) dv$ .

$dp/dt = R/v + b/t^2 v^2$ ,  $d^2 p/dt^2 = -2b/t^3 v^2$ .

For  $t=273$  absolute temperature and  $v=1$  cubic foot,  $S_t = 191.84 = B + 2b/t^2 v = B + 963200/(273)^2$ .

∴  $B = 178.943$ .

For  $t=290^\circ$  absolute or  $17^\circ C.$ ,  $S_t = 178.943 + 963200/(290)^2 = 190.396$ .

$5273.3 \div 190.396 = 27.7^\circ C.$ , the amount the temperature would rise if total work were converted to heat.

135. Proposed by F. P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Defiance College, Defiance, Ohio.

What force acting at an inclination  $\omega$  with a horizontal line on the center of a wheel of given weight will roll the wheel over an immovable cylindric log whose diameter is  $(1/m)$ th that of the wheel?

Solution by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, O.

If the meaning is to find the force  $F$  which will *start* the rolling the following is the solution:

If  $\phi = \cos^{-1} \left( \frac{2\sqrt{m}}{m+1} \right)$  = the angle the radius of the wheel through the point of contact with the log, and  $\phi + \omega = \alpha$ , the angle included by this radius and the direction of the required force, and  $W$  = the weight of the wheel, we have, taking moments about the point of contact,

$$F \cdot r \sin \alpha = W \cdot \frac{2r\sqrt{m}}{m+1}, \text{ giving } F.$$